Decisions under uncertainty

A bioeconomic approach to managing invasive species in Alaska:

The case of Elodea in Chena Slough, Fairbanks

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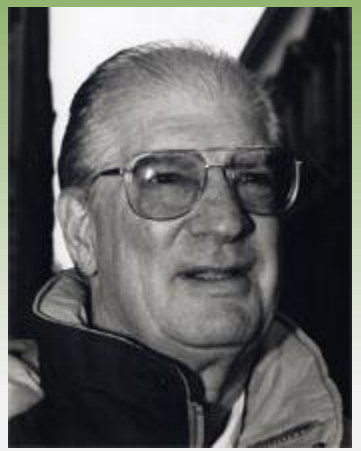
Outline

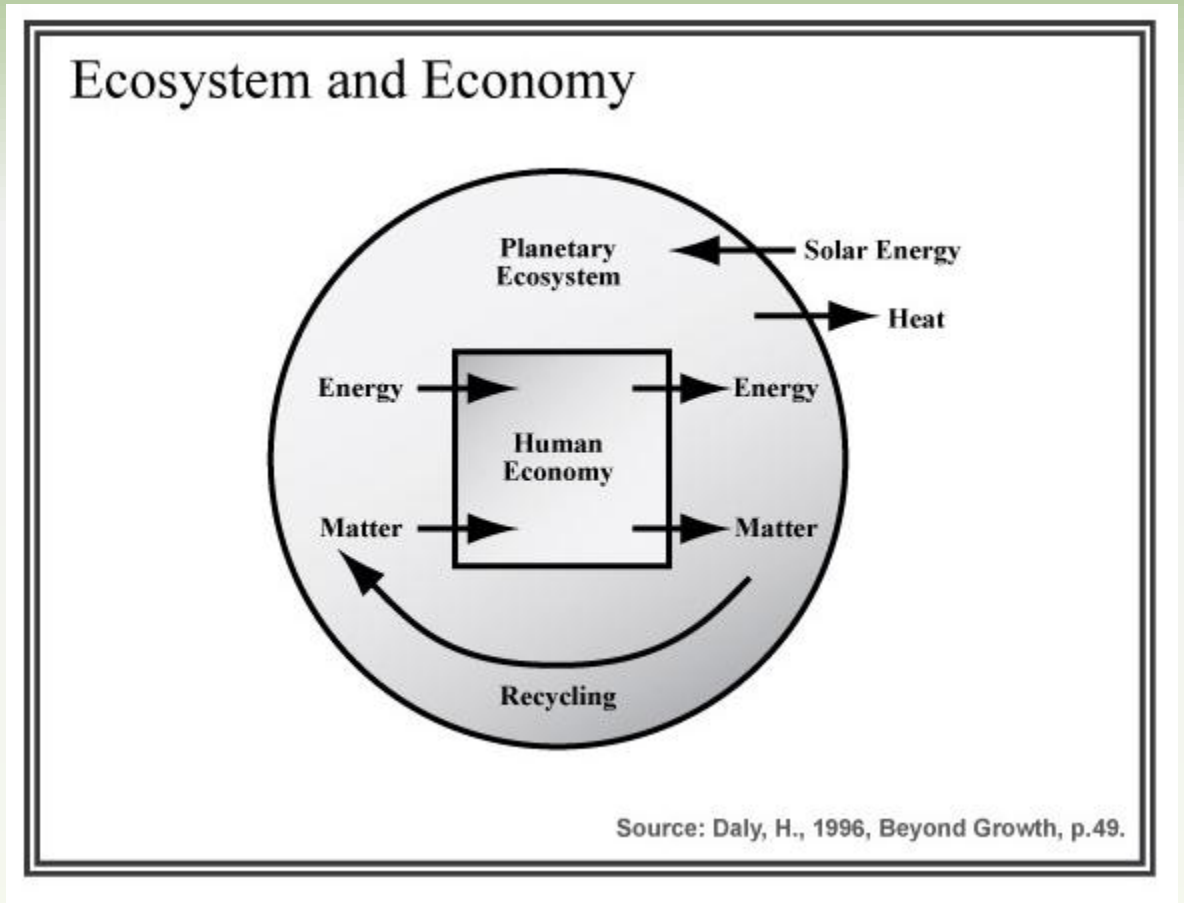
- Ecological economics
- New partnerships
- Valuation of ecosystem services
- Decision and risk analysis: the case of Elodea in Fairbanks
  - Is it worth taking action?
  - If so, what to do and how much to invest?
- Limitations
- Extensions

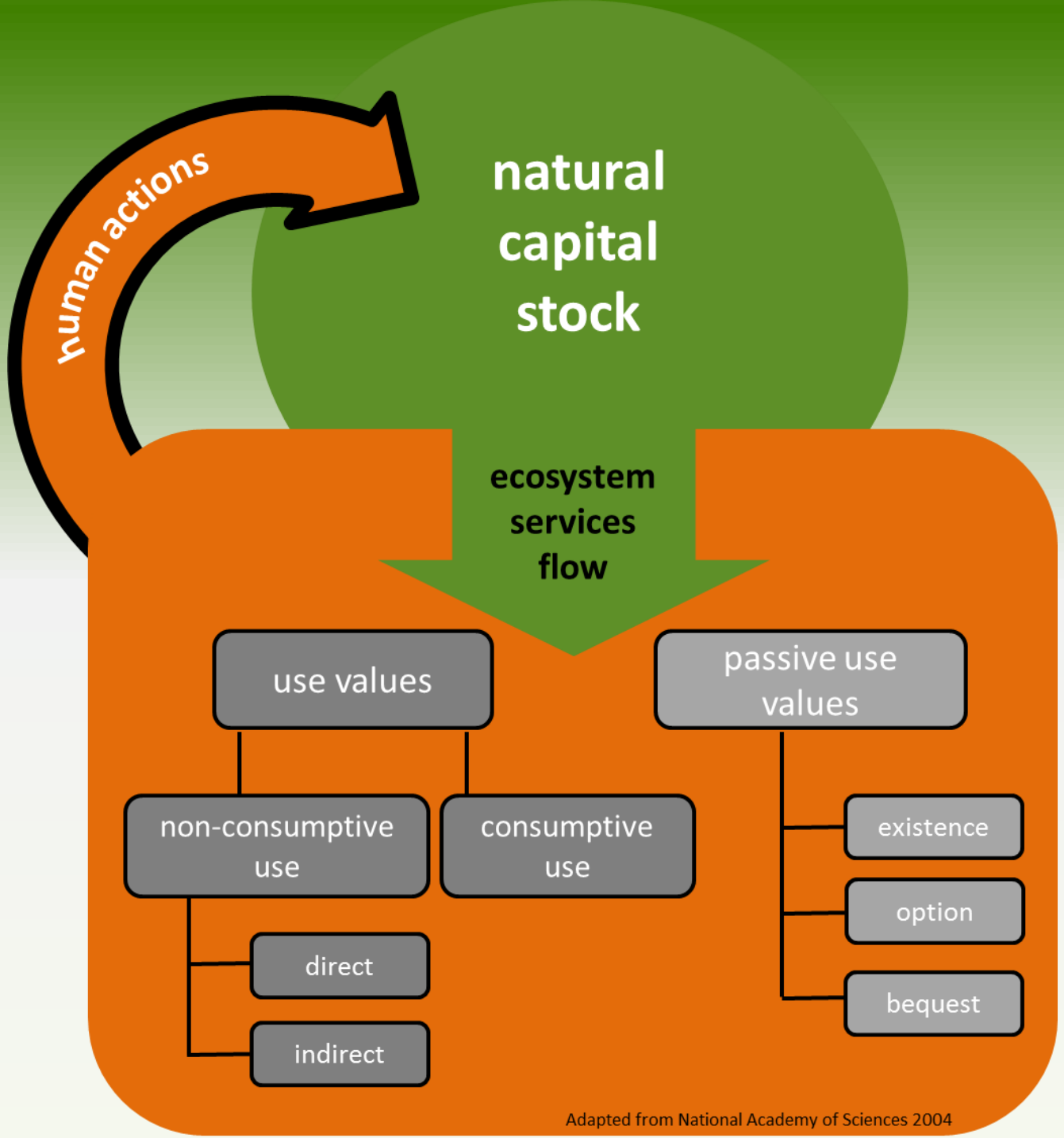
From Greek: Οἶκος "house"

"The economy is a wholly owned subsidiary of the environment, not the reverse."



Herman E. Daly





Adapted from National Academy of Sciences 2004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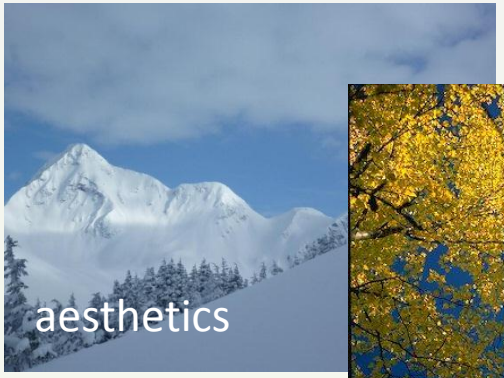
Ecosystem Services

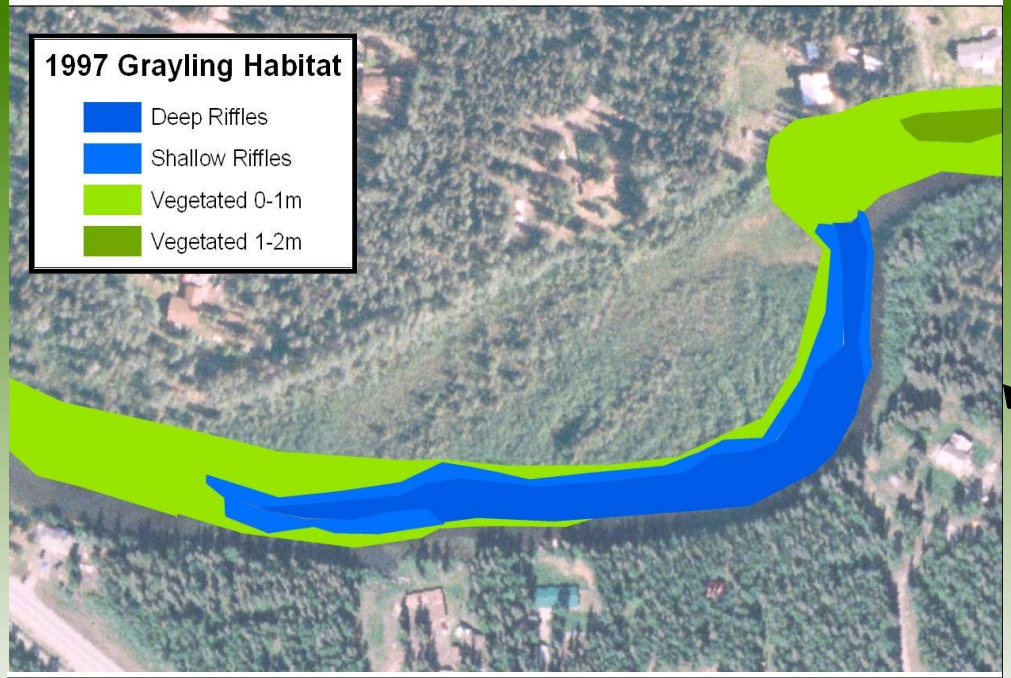


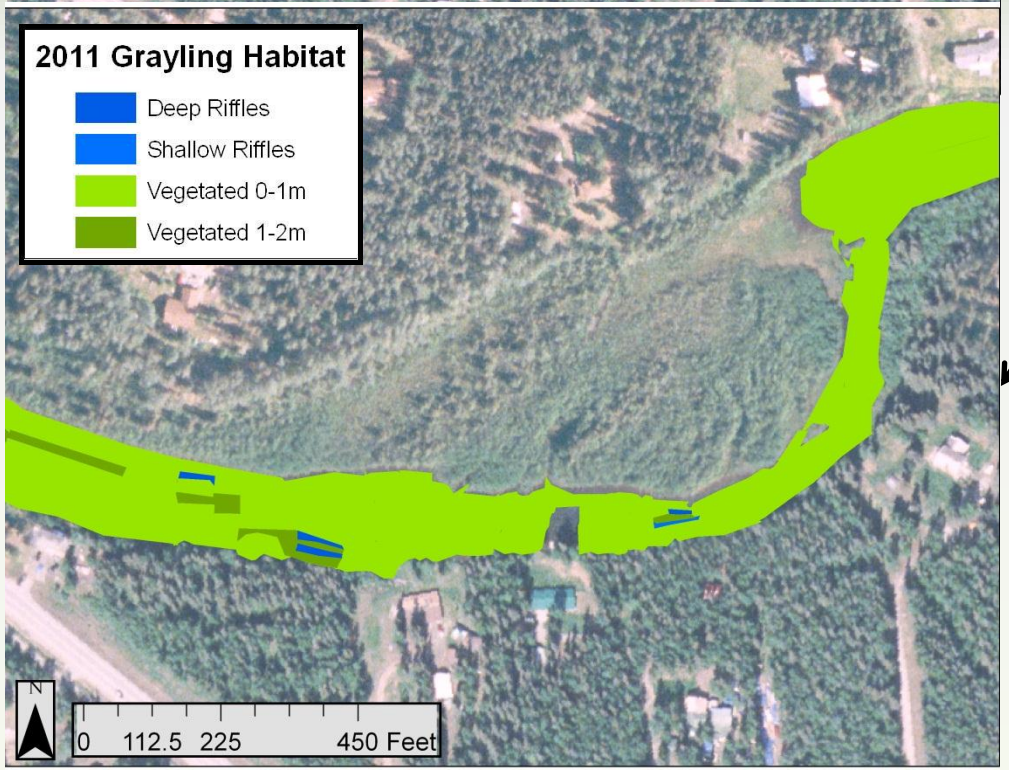
How does this relate to Elodea?

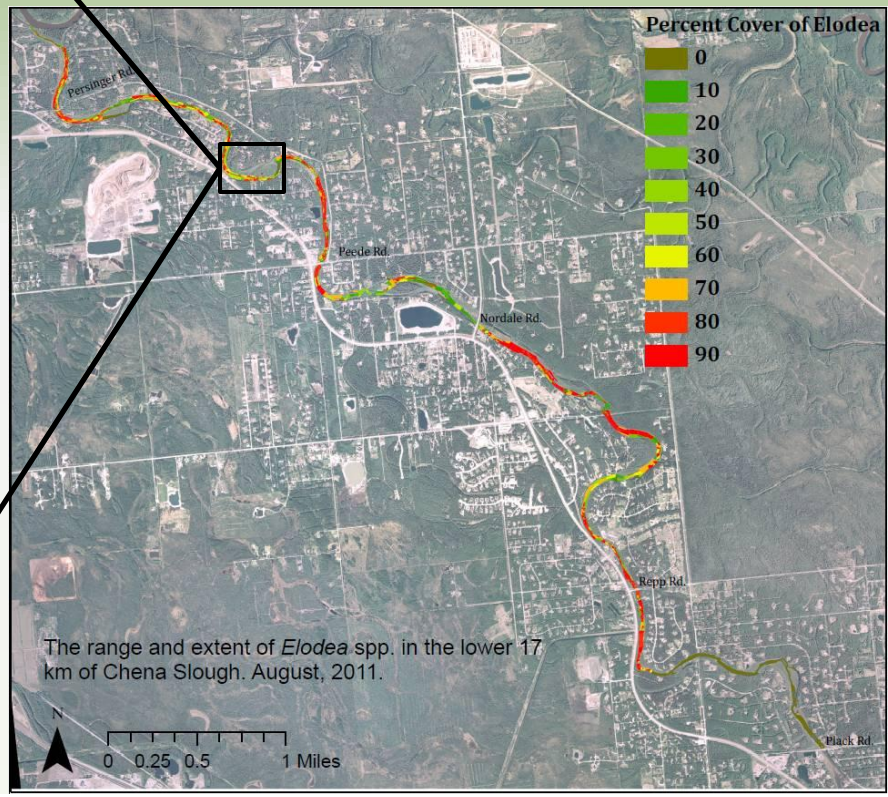
- Appraisal of damages
- Costs of management actions
- Estimation of
  expected avoided damages give mgmt. action

Elodea in Chena Slough, Fairbanks

2000: assumed “aquarium dump”
2011: 58 acres of Elodea monoculture







Sources: Larsen and Lisuzzo 2012,
Fairbanks Soil & Water Conservation District


Fairbanks Soil & Water Conservation District


Soil & Water Conservation District


NO
FUN
FEST

Parameter assumptions

- Damage values:
  - Grayling: $1.01/m^2 annually (Duffield et al. 2001)
  - Property: $0.46/m^2 annually (Zhang&Boyle 2010)
  - Canoeing: $0.13/m^2 annually (Loomis 2005)
  - Total: $1.61 /m^2 annually
  - Habitat: $97.37/m^2 annually (Johnston 2005)

- Management options:
  - Suction dredging: $1.39 - $2.46/m^2
  - Herbicides: $0.12 - $0.28/m^2

  (incl. permitting costs 13% to 100% of treatment cost)
  - Monitoring: $0.28/m^2

- Discount rate: 4%
- Time horizon: 100 yrs


Fairbanks Soil & Water Conservation District

Management Options

- OPTION A – do nothing
- OPTION B – treat to do something
- OPTION C – treat to maximize benefits

- Decision criteria:

NPV greater than zero!

$$NPV = \sum_{t=1}^{100} \frac{(B_t - C_t)}{(1+d)^t}$$

- Results shown levelized

$$NPV_{levelized} = NPV\left(\frac{d}{1-(1+d)^{T}}\right)$$


Fairbanks Soil & Water Conservation District

Ecological model

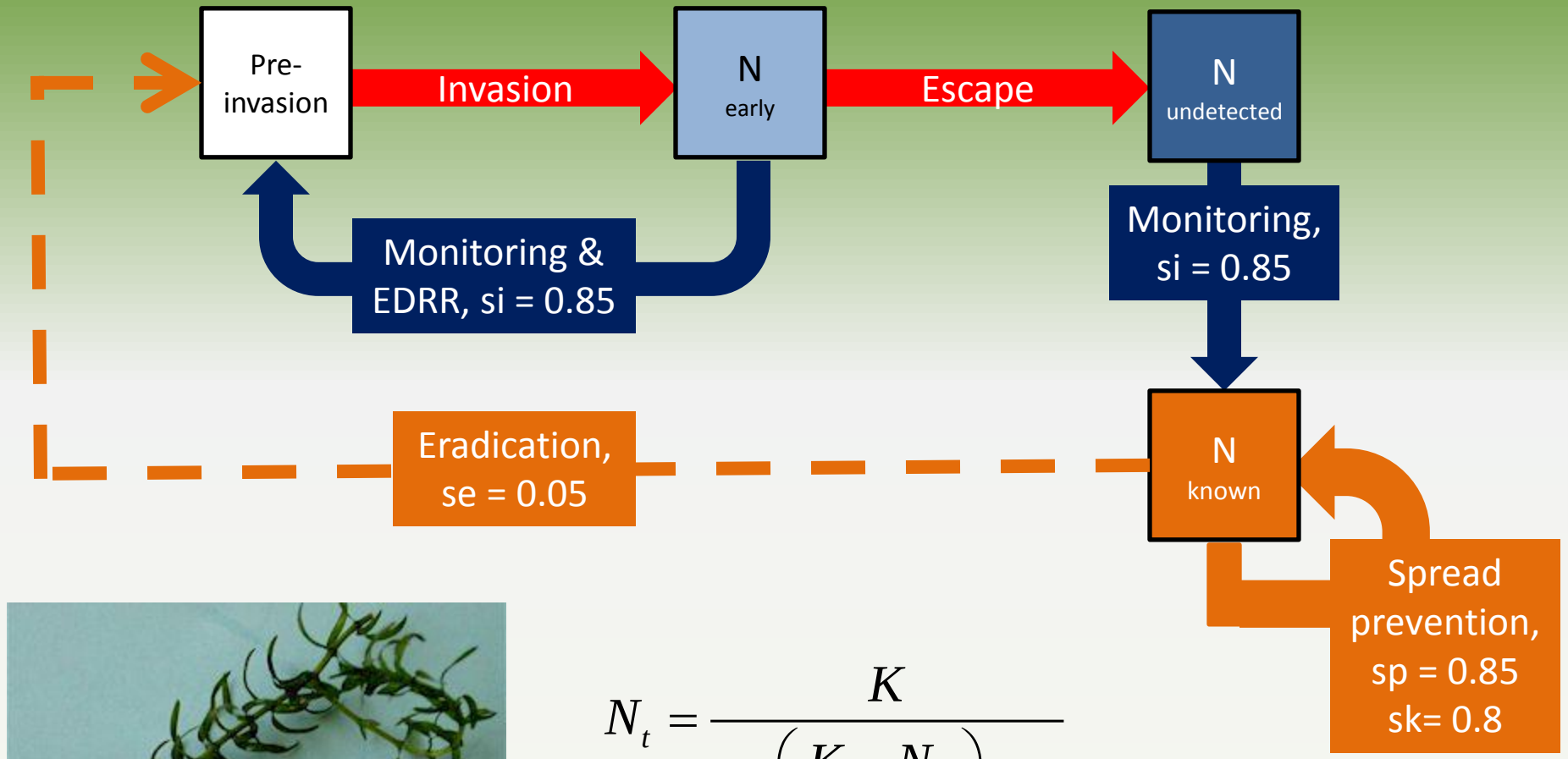
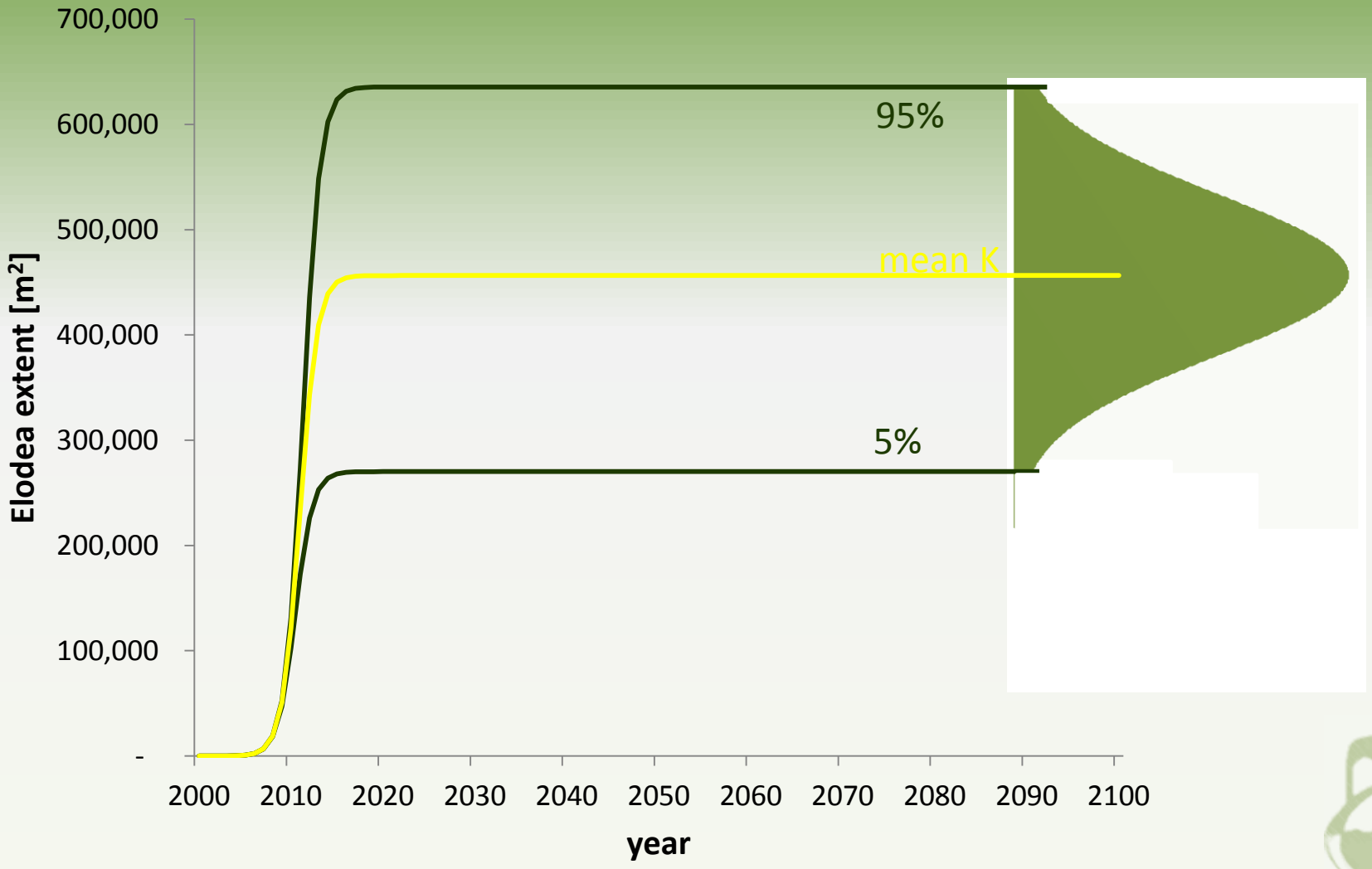



Photo: AWC America

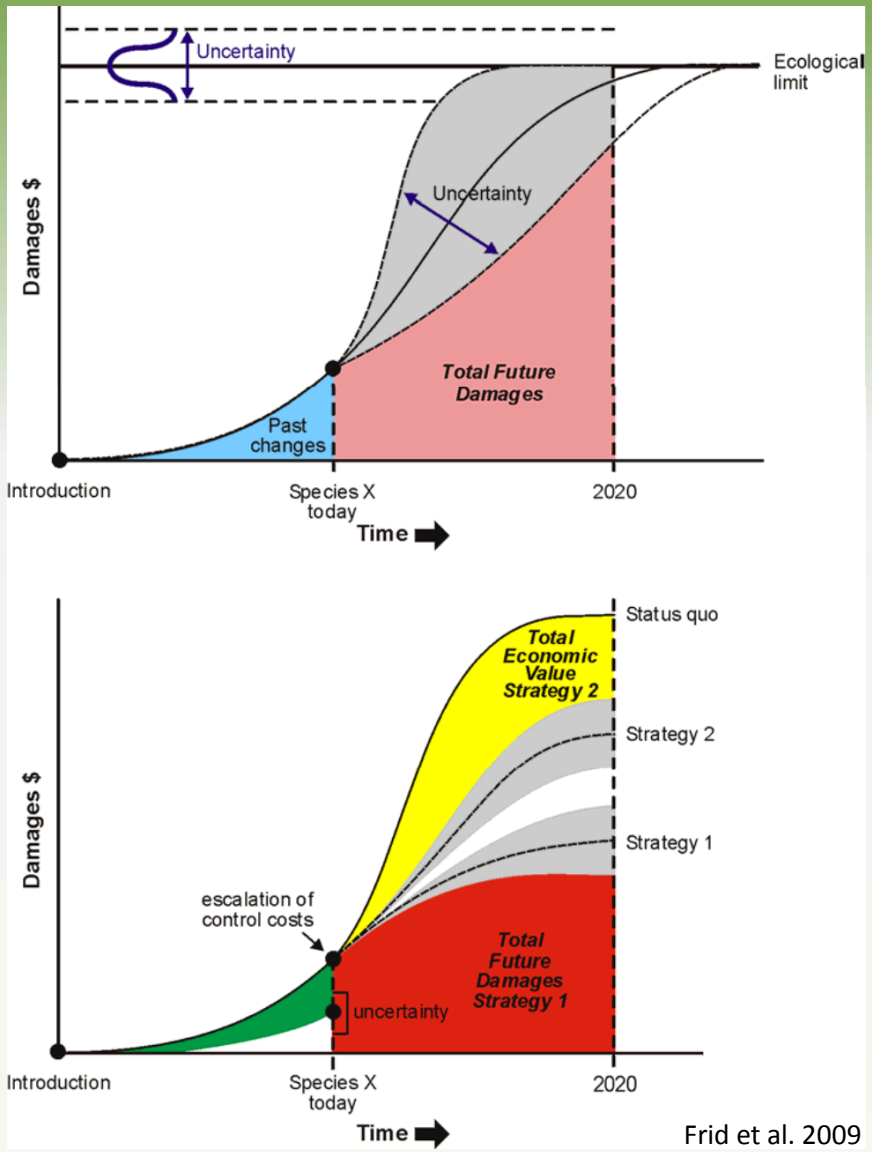
$$N_t = \frac{K}{1 + \left(\frac{K - N_0}{N_0}\right) e^{-rt}}$$

Frid et al. 2009

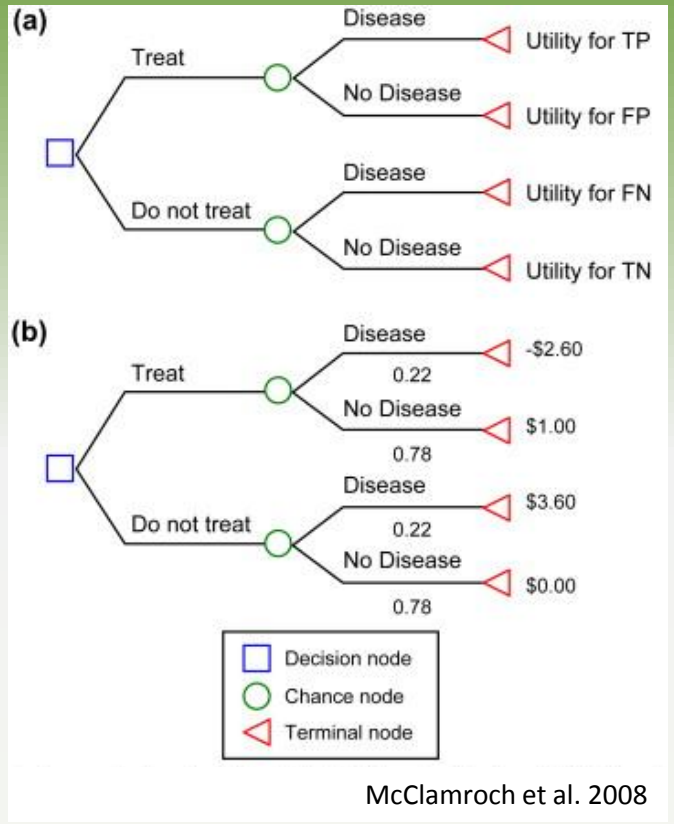
Simulating different ecological outcomes



Quantitative Risk and Decision Analysis



Frid et al. 2009



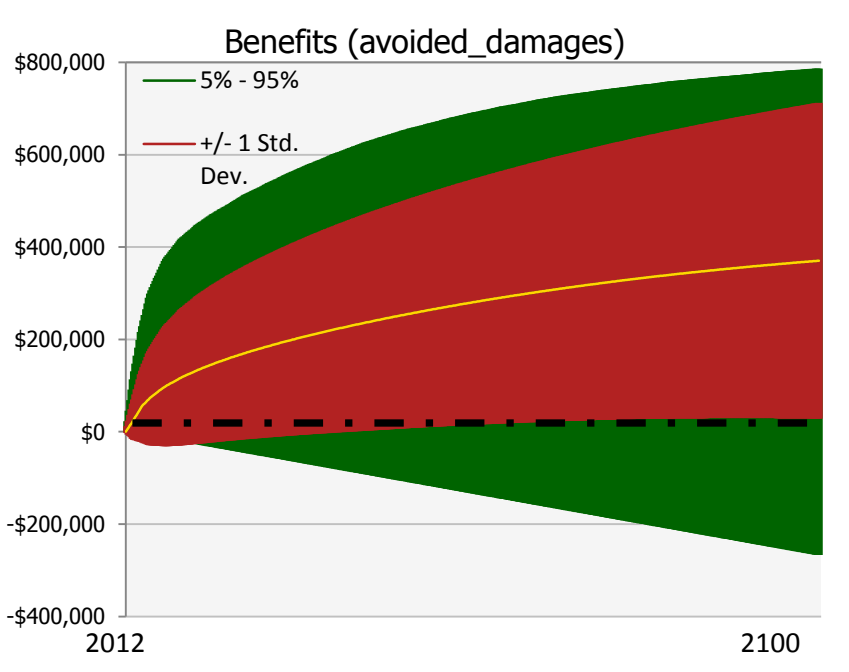
McClamroch et al. 2008

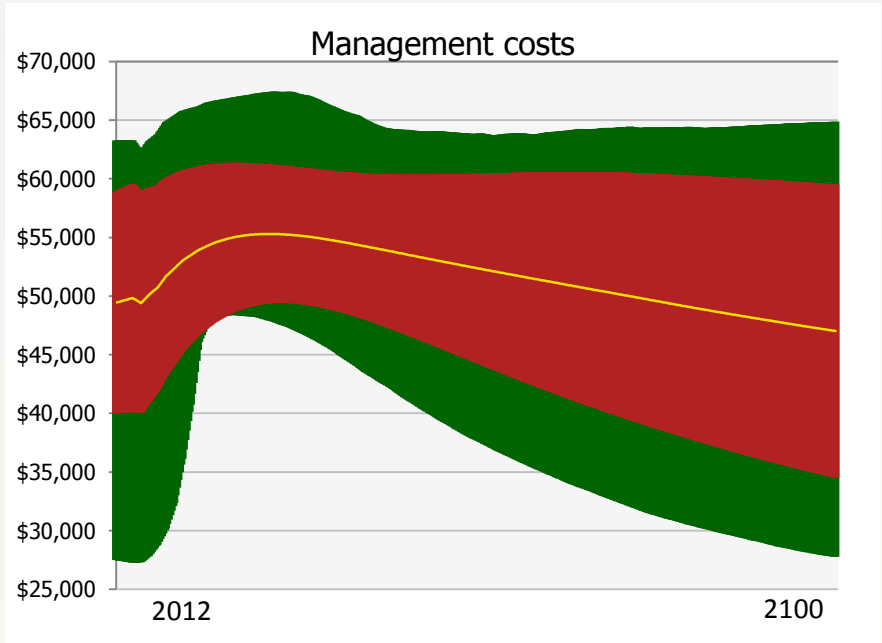
Simulation Results

	DO NOTHING		DREDGE	Herbicides	
Treatment budget	none	none	what it takes	what it takes	do little
Passive use values	none	yes	none	none	none
NPV (mean)	$-16.9 million	$-1032.9 million	$-4.3 million	$5.8 million	$1.4 million
NPV levelized/yr	$-0.7 million	$-42.7 million	$-0.2 million	$0.2 million	$0.1 million
B/C ratio (mean)			**0.59**	**3.7**	**2.1**
B/C ratio (low)			-0.49	1.4	-14.0
B/C ratio (high)			3.77	12.6	13.6
p (NPV<0)			66%	0%	26%

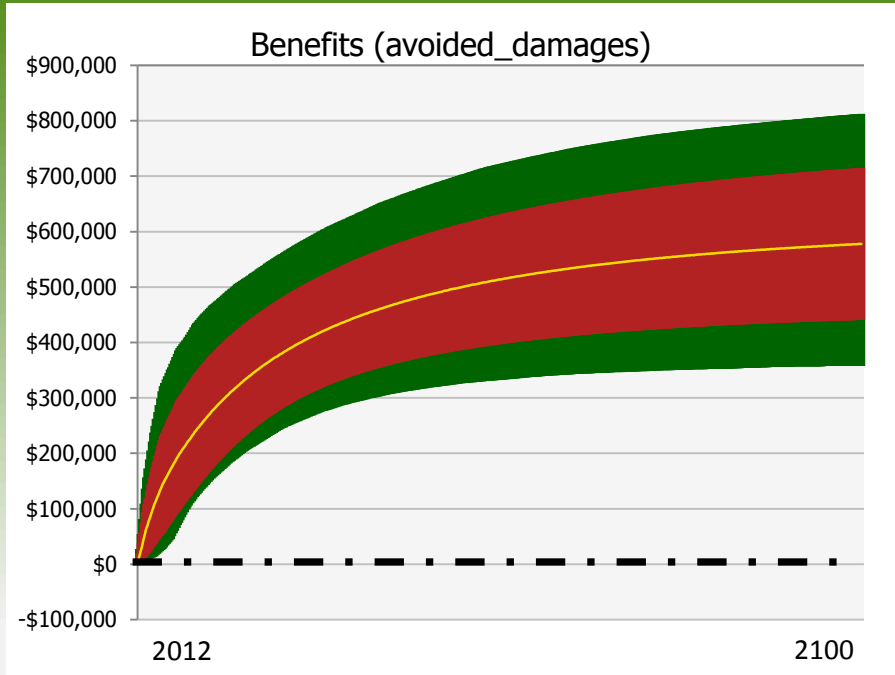
Let's look in more detail!

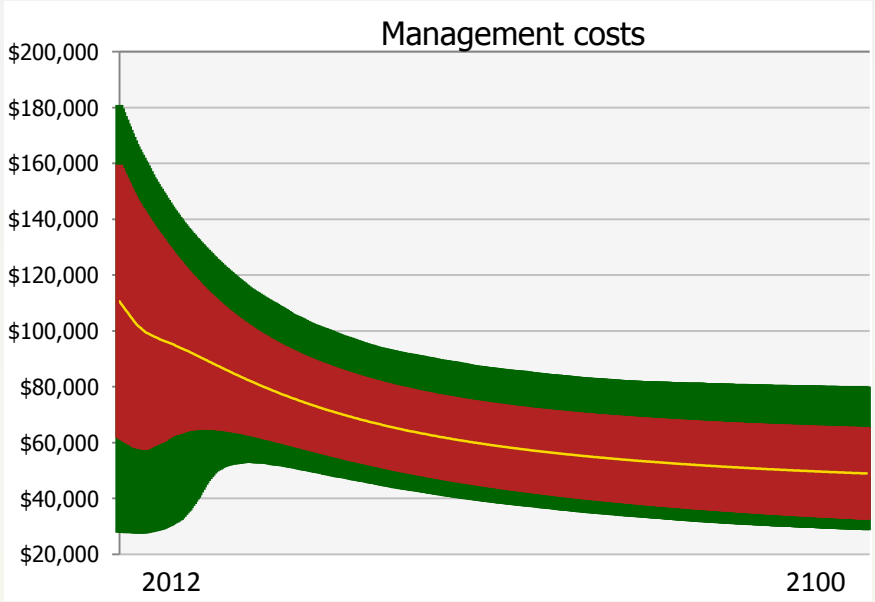
Treat insufficiently $70,000/year





Treat sufficiently $180,000/year





Limitations

- Actual values of ecosystem services much higher than estimated
- Model only as good as assumptions
- Economic-ecological-linkages
- Unintended consequences
  - Risk for non-target organisms
- Data intensive

Extensions

- Additional decision making tool
  - times of tight budgets
- D. vex, RCG
- Quantify opportunity cost of delayed action
- Scenario: Elodea crash (Simpson 1984)
  - Logistic growth w/ lag effect
- Biocontrol agents

Thank you

- Darcy Etcheverry
  Fairbanks Cooperative Weed Management Area
- Nick Lisuzzo, USDA F.S.
- Amy Larson, NPS
- Cecil Rich, USFWS
- Matt Carlson, UAA
- Lindsey Flagstad, UAA
- Many more …

Questions?

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www.iser.uaa.alaska.edu

Valuation of Ecosystem Services
http://www.iser.uaa.alaska.edu/Projects/voes/

Photo: Fairbanks Soil & Water Conservation District